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In Cooperation with the University of Nebraska, State Soil Survey Department of the Conservation and Survey Division

SOIL SURVEY
OF
BUTLER COUNTY, NEBRASKA

BY
A. W. GOKE, U. S. Department of Agriculture, in Charge
and G. E. BATES, Nebraska Soil Survey

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SOIL SURVEY OF BUTLER COUNTY, NEBRASKA

By A. W. GOKE, U. S. Department of Agriculture, in Charge, and G. E. BATES, Nebraska Soil Survey

COUNTY SURVEYED

Butler County is in eastern Nebraska, in the fourth tier of counties from the south boundary of the State and in the third from the east boundary. David City, the county seat, is about 65 miles west of Omaha. The county comprises 588 square miles, or 376,320 acres.

The county includes parts of four physiographic divisions, defined by G. E. Condra, University of Nebraska, as the Nebraska plain, drift hills, loess hills, and the Platte plain.

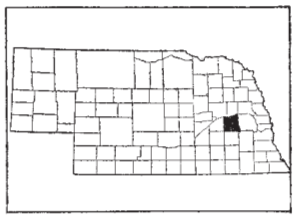

FIGURE 1.—Sketch map showing location of Butler County, Nebr.

The Nebraska plain formerly occupied the greater part, if not all, of the area now included in Butler County. It was mantled with a thick deposit of fine-textured silty material, now known as loess, and was probably comparatively smooth. Subsequent erosion either modified the surface of the old plain over large areas or entirely removed the loessial material, giving rise to the drift hills, loess hills, and Platte plain previously mentioned. The part of the Nebraska plain still intact occupies the southwestern part of the county and comprises about 65 per cent of the uplands. Its northern boundary lies immediately south of the bluff lands bounding the south side of the Platte River Valley from the western county line to a point north of David City. From this point, the eastern boundary of the plain extends southeastward to about the head of Bone Creek and then runs in a southerly direction to the south county line. The southern and western boundaries lie outside Butler County. The part of the Nebraska plain within the county is a comparatively smooth, loess-covered upland plain, sloping gently toward the east. Parts of it are dissected by Big Blue River and its tributaries, whose narrow, gradually sloping valleys create a gently rolling surface. Most of the plain, however, is smooth and is modified only by small, narrow, V-shaped drainage ways. It is characterized by numerous shallow basinlike depressions of various sizes.

The drift hills area of Butler County lies east of the Nebraska plain and south of the main highway between David City and Wahoo, Saunders County. It includes about 10 per cent of the uplands. This area, as a whole, has been severely eroded. The loessial mantle has been entirely removed in most places and the underlying glacial drift exposed. Continued erosion into the drift has created a hilly relief. Drainage ways are numerous and deeply intrenched

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and are generally separated by narrow divides. The valley slopes are steep. Locally the higher and broader divides have escaped destructive erosion and occur as isolated remnants of the former, nearly level loess plain. The largest remnants occur along the Union Pacific Railroad northwest of Loma and on the high divide between Oak Creek and Oak Branch, in the southeastern part of the county.

The loess hills area of the county occupies the remainder of the uplands and lies chiefly south of the Platte River Valley in the northeastern part of the county. Throughout this area the surface features are somewhat similar to those in the drift hills, but stream dissection is not so severe. The loessial mantle, although severely eroded, has not been entirely removed, except near the base of slopes along the deeper drainage ways. The general surface is strongly rolling, but the slopes are smoother, shorter, and more gradual than those in the drift hills, and uneroded remnants of the old Nebraska plain are more numerous.

The Platte plain, the fourth physiographic division mentioned, is from 100 to 150 feet below the general level of the uplands, from which it is separated in most places by a comparatively steep, more or less blufflike slope. It includes the terraces or benches and flood plains along Platte River and varies in width from 4 to 6 miles. The terraces occur at several different levels, depending on the depth to which the stream had cut prior to their deposition. All of the benches, however, are above overflow from the main stream. Their general surface is smooth, although that of the older and higher terrace remnants has been somewhat modified by erosion and the surface of the more sandy benches is locally rather hummocky from wind action. The transition between the different terrace levels and between the lower terraces and the flood plains is commonly marked by a short, steep slope.

The flood plains occupy the lowest positions in the Platte plain. They border existing and old stream channels and are locally subject to overflow during periods of high water. The surface, in general, is almost level, except where it is modified by tributary streams or overflow channels, slight elevations, and shallow depressions.

The average elevation of Butler County is about 1,450 feet above sea level. It ranges from approximately 1,300 feet on Platte River, in the extreme northeast corner, to about 1,640 feet in the uplands north of Brainard, in the southeastern part. The Nebraska plain has a uniform elevation of about 1,600 feet above sea level. The elevation in the loess hills division is about 50 feet less and that in the drift hills is approximately 100 feet less than in the Nebraska plain. The Platte plain has an average elevation of about 1,350 feet above sea level. The general slope of the county is to the east.

Butler County is drained by Platte River and Big Blue River, together with their tributaries. Tributaries to the latter stream invade the entire southern part of the county. The divide between the two rivers extends northwest-southeast across the county. Each drainage area occupies about half the county. North of the divide the surface run-off is northward and directly into the Platte River, except in a small area in the east-central part of the county, which drains southeast through Wahoo Creek, a tributary of Platte River in Saunders

County. South of the divide, drainage is in a general southerly direction to Big Blue River.

Settlement in Butler County began in 1857 along Big Blue River, Skull Creek, and other large streams. The county was organized in 1868 and according to the Federal census had 9,194 inhabitants in 1880. In 1920 the population had increased to 14,606, of which number about two-thirds were living on farms. The rural population is fairly evenly distributed, although the density is somewhat greater in the vicinity of the towns and along the railroads.

David City, Bellwood, Octavia, Linwood, Ulysses, Rising City, Surprise, Brainard, and Bruno are the most important towns. David City, in the central part of the county, is the county seat and has a population of about 2,400. The other towns are much smaller but are well situated to serve as market centers in the rural districts. They are all connected with railroads, which cross the county in several directions and furnish good connections with outside points.

The main public highways are kept in good condition. None of the highways has been hard surfaced, but they are kept well graded and thoroughly packed and are dragged after each heavy rain so that they seldom become impassable, even during prolonged periods of rainy weather. Steel or cement bridges and culverts are common, even on the minor roads. Excellent railroad connections with Lincoln and Omaha give Butler County good marketing facilities. In Omaha and Lincoln there is a demand for practically all the livestock, dairy, and other farm products of the county. Owing to the small urban population, the home demand for farm products is very small.

All communities are reached by rural free delivery of mail, and telephones are in common use throughout the county.

CLIMATE

The climate of Butler County is favorable for diversified farming. It is well suited to a wide variety of farm crops and to stock raising. Crops seldom suffer from winterkilling. The long, warm, summers with their uniform temperature are especially favorable for corn, and the moderate temperature prevailing during the spring months assists the development of the wheat and oats crops.

The average date of the last killing frost is April 28, and that of the first is October 8. This gives an average frost-free season of 163 days, which is ample for maturing the ordinary farm crops. The date of the earliest recorded killing frost was September 12 and of the latest was May 27.

Of the mean annual precipitation of 28.96 inches, 11.69 inches, or about 40 per cent, falls during June, July, and August, the principal part of the growing season. The driest months are December, January, and February, the mean annual precipitation of each being less than an inch. The rainfall is fairly uniform during the growing season, although it is interrupted by short dry spells during August and September. Droughts are practically unknown.

Strong winds are common, especially during the spring months and late in the fall. The prevailing winds are from the northwest during winter and from the south or southeast in summer.

Table 1, compiled from the records of the Weather Bureau station at David City, gives the normal monthly, seasonal, and annual temperature and precipitation for the county.

TABLE 1.—*Normal monthly, seasonal, and annual temperature and precipitation at David City*

[Elevation, 1,619 feet]

Month	Temperature			Precipitation			
	Mean	Absolute maximum	Absolute minimum	Mean	Total amount for the driest year (1894)	Total amount for the wettest year (1915)	Snow, average depth
	° *F.*	° *F.*	° *F.*	*Inches*	*Inches*	*Inches*	*Inches*
December	26.6	64	−20	0.88	1.00	0.41	5.4
January	22.4	61	−30	.74	.60	1.22	6.8
February	23.6	72	−30	.96	.50	3.41	7.7
Winter	24.2	72	−30	2.58	2.10	5.04	19.9
March	35.5	87	−11	1.51	.30	2.01	6.7
April	49.1	96	10	3.09	1.85	2.39	2.4
May	59.6	100	22	4.27	1.20	4.52	.2
Spring	48.1	100	−11	8.87	3.35	8.92	9.3
June	69.6	104	39	4.22	6.55	5.74	.0
July	74.5	107	46	4.05	1.00	9.74	.0
August	72.2	106	36	3.42	.15	6.85	.0
Summer	72.1	107	36	11.69	7.70	22.33	.0
September	64.5	101	27	2.79	.70	6.75	.0
October	52.1	90	10	1.94	1.65	.75	.7
November	37.5	76	−8	1.09	Trace.	1.01	2.9
Fall	51.4	101	−8	5.82	2.35	8.51	3.6
Year	49.0	107	−30	28.96	15.50	44.80	32.8

AGRICULTURE

Agriculture in Butler County consists of diversified farming. The principal crops, named in the order of their acreage, are corn, wheat, oats, alfalfa, rye, and potatoes. Cattle, hogs, poultry, and horses are the principal kinds of livestock on the farms, although a few farmers keep a small flock of sheep.

Table 2, compiled from the reports of the Federal census, gives the acreage and production of the principal crops of the county in stated years and shows the general trend of agriculture during the last 40 years.

TABLE 2.—*Acreage and production of principal crops in stated years*

Crop	1879		1889		1899		1909		1919	
	Acres	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*	*Acres*	*Bushels*
Corn	38,250	1,640,046	114,818	5,523,861	150,738	5,853,070	118,658	3,953,276	112,319	3,148,323
Oats	7,097	195,959	41,146	1,353,909	68,402	2,393,440	55,932	1,392,288	54,747	2,066,995
Wheat	51,461	529,921	6,456	81,650	22,738	293,220	68,619	1,502,213	72,734	909,836
Rye	491	5,011	918	15,766	4,302	57,390	153	2,077	807	11,421
Barley	1,762	32,579	192	3,710	2,281	66,010	237	4,657	2,209	62,667
Potatoes	-------	58,425	4,471	501,195	1,472	177,901	1,286	99,077	942	48,729
Prairie hay	[1] 5,796	[1] 9,458	[1] 32,825	[1] 42,190	17,228	20,486	14,777	21,356	13,252	15,791
Alfalfa	-------	-------	-------	-------	333	827	2,776	7,770	8,521	17,475
Clover	-------	-------	-------	-------	1,762	3,110	165	224	267	249

[1] The census figures for 1879 and 1889 include both prairie hay and cultivated hay acreage and tonnage.

Corn occupies the largest acreage of any crop in Butler County. It is grown on about 50 per cent of the farm land and is used in various forms as feed for practically all livestock. On many tenant farms, where little livestock is kept, corn is the chief cash crop. Most of the corn is husked in the field and is stored in cribs for winter feeding. Many farmers fence off a few acres of unhusked corn in order that cattle and hogs may hog down the crop, thereby saving the labor and expense of husking. A few farmers have silos and cut from 10 to 20 acres of corn each year for silage.

According to the 1920 Federal census, 112,319 acres were devoted to corn in 1919 and the total yield was 3,148,323 bushels. The usual yield on the soils of the uplands and the finer-textured terrace soils is 40 or 50 bushels to the acre, except on Knox silt loam soil, where the average is somewhat lower. The sandy terrace lands and the poorly drained bottom lands yield 20 or 30 bushels to the acre, depending on the season.

Corn does well on various kinds of soil. It does fairly well on land too sandy for small grain and is therefore practically the only cultivated crop on the Valentine and Sparta soils. It does best, however, on the finer-textured well-drained soils of the county where it can be grown in rotation with wheat, oats, and alfalfa. Reid Yellow Dent, Nebraska White Prize, and Iowa Silvermine are the principal varieties of corn grown in Butler County.

Wheat ranks next to corn in acreage. The census report of 1920 shows that 72,734 acres devoted to wheat in 1919 yielded 909,836 bushels. Most of the wheat is grown in rotation with corn, oats, and alfalfa and is sold as a cash crop. In certain localities wheat occupies the major part of the acreage of the farm, especially on the Hastings and Crete soils, which are well adapted to it.

Some damage to the wheat crop is caused by rust, especially if unusually warm and moist weather prevails during May and June. In 1923, the average acre yield was reduced several bushels by rust. The Hessian fly has occasionally reduced the yield, but the damage caused by this insect can usually be curtailed by late fall seeding.

The tendency during the last few years has been toward stacking the wheat and threshing it later in the season when labor is more plentiful. This method is practiced almost exclusively in localities where the wheat acreage on the farms is small. In areas of greater wheat acreage, however, the crop is threshed from the shock and is either hauled directly to the market or is stored in bins. The straw is left in the field and livestock is given access to the stacks.

Oats rank third in acreage. The census report shows 54,747 acres grown in 1919, with a yield of 2,066,995 bushels. The oats yield depends on climatic conditions during the spring months. Low moisture and high temperature usually result in decreased yields. Early seeding usually favors the highest yields, provided the temperature and moisture conditions are normal. The crop does best on the finer-textured well-drained soils. Sandy soils are not well adapted to it on account of the danger of the sand blowing and exposing the roots. On heavy alluvial soils the plants often make an unusually rank vegetative growth at the expense of the grain, and the crop is subject to lodging.

Oats are cut with a binder, stacked, and threshed later. Practically all of the grain is fed on the farms, mainly to work animals.

The straw has a high feeding value and is used on many farms in place of hay for horse feed during the winter months. Some of the straw is baled and shipped. Kherson is the principal variety of oats grown. It gives excellent results on the heavier soils.

Barley was grown on 2,209 acres in 1919 and produced 62,667 bushels. It is usually cut with a binder and used for feed. Rye is of minor importance. The census reports show that 807 acres produced 11,421 bushels in 1919. This crop is grown mainly on light, sandy, and more or less droughty soils subject to wind erosion, where it does better than other small-grain crops. Most of the grain is fed on the farms where it is produced. During the fall rye is used for pasture with very little injurious effect on the next year's growth. The ordinary yield is 10 or 15 bushels to the acre. On sandy soils subject to blowing during the winter months rye is sown during the fall to serve as a cover crop and is plowed under in the spring before the planting of corn.

Potatoes are grown on many farms to supply home needs, and in 1919, 942 acres yielded 48,729 bushels. This crop does best on the sandy soils of the river terraces, yielding from 50 to 100 bushels to the acre.

Truck gardening is not practiced on a commercial scale. Only enough peas, lettuce, radishes, cabbage, cauliflower, turnips, carrots, parsnips, beets, tomatoes, onions, and sweet corn are grown for home use. Some watermelons and cantaloupes are grown on the sandier soils of the Platte River Valley and are sold mainly in surrounding towns.

Most farmers have a small orchard containing principally apple, peach, plum, and pear trees. Fruit is grown only for home use. The farm orchards seem to produce best in the eastern part of the county.

Wild hay exceeds all other hay crops in acreage. The census of 1920 reports 13,252 acres, yielding 15,791 tons in 1919. The wild hay is cut chiefly from the more poorly drained bottom-land soils and from the rougher uplands. The highest yields are obtained on the bottom lands where drainage is rather poor. The upland areas of hay are small and occupy isolated patches on the smoother slopes. The principal wild hay grasses are big bluestem, Indian grass, stipa, and slough grasses. Big bluestem dominates on the finer-textured upland and terrace soils; stipa grows on the more sandy well-drained soils; and slough grass, principally *Spartina spartinoides*, prevails in the poorly drained situations. The usual yield of prairie hay is about 1 ton to the acre.

Alfalfa is an important hay crop on the well-drained uplands and terraces. The census shows 8,521 acres in 1919. This plant does well on the rolling areas of Marshall silt loam, but on poorly drained land growth is not so good and often the stand is winterkilled. A successful stand is difficult to obtain on Knox silt loam, except where that soil has been previously used for sweet clover. Good results have been obtained on Lamoure silt loam, after the land has been artificially drained.

Sweet clover has been receiving some attention recently, and many farmers favor the crop for cattle and hog pasture and for improving the soil. Various methods are now being tried to determine a crop-

ping system in which sweet clover may be used to best advantage. A few farmers have reported excellent success by growing the crop in connection with wheat. Under this system, scarified sweet-clover seed is sowed early in the spring on land planted to winter wheat the preceding fall. The wheat acts as a nurse crop until harvest, after which time the sweet clover produces a hay crop and is then used for pasture until the land is needed for the succeeding wheat crop.

The cattle industry in Butler County holds a prominent place in agriculture. It consists largely of the winter feeding of beef animals and the raising of dairy cattle. Most of the beef cattle are purchased as feeders from the Omaha market, are fed corn and alfalfa for 60 to 90 days, and are returned to the market as fattened cattle. Only a few farmers raise beef cattle, owing to the small acreage of grazing land on most farms. Dairy cattle, however, are raised on many farms. Dairying is receiving more attention, and many farmers are enlarging their herds. During 1924 several carloads of Holstein cows were purchased by the farmers in order to improve their herds. Most of the surplus dairy products are sold to near-by cream stations for shipment to the Omaha creameries. Only enough butter is made on the farms for home use.

Hog raising is an important branch of the livestock industry. Every farmer has a few hogs, and large herds are raised on many farms. Duroc-Jersey, Poland China, and Berkshire are the leading breeds. A few farmers have purebred herds, though most of the animals are grade stock. The common practice is to fatten the hogs on corn either in feeding yards or by turning them into the fields and allowing them to hog down the corn in the fall. On many farms the hogs are fed on the corn wasted by fattening cattle. Alfalfa is usually added to the corn ration, and during the summer the pigs are often allowed to run in the alfalfa fields until the third crop is ready to cut. Hog raising has been disastrously affected at times by the prevalence of hog cholera, and much attention is being given to the elimination of this disease through vaccination and sanitation.

Sheep raising does not receive much attention, and there are only a few flocks of sheep in the county. Some sheep are purchased during the fall, fattened on corn and pasturage, and sold when prices are favorable.

Most of the work animals, which are principally horses, are raised on the farms. The horses are of heavy draft types, the Percheron being the favorite breed. Much improvement has been made in horses since the introduction of purebred stallions. Some mules are raised, and the local demand for these animals is greater than the supply. Since the advent of the automobile and tractor on the farms, and with the high price of feeds, a minimum of work animals is kept. Most farmers keep from four to six horses for each 160 acres of land.

Poultry is kept on most farms as a side line in connection with farming. The poultry industry is receiving increased attention and on many farms serves as a continual source of income for the purchase of groceries and other household necessities. Many farmers raise young chickens, which are purchased by local buyers for shipment to distant markets. The Leghorn, Barred Plymouth Rock, Rhode Island Red, Orpington, and Wyandotte are the most popular breeds of chickens.

Systematic crop rotation is not practiced, although rather indefinite systems are used by many farmers. When alfalfa sod is broken, the land is usually devoted to corn for two years, oats for one year, wheat, rye, or barley one or two years, then corn again.

Corn is often planted on the same land three or four years in succession, and alfalfa land is seldom broken so long as the crop remains profitable. Under the prevailing farming practices, crop rotations are governed more by the demand and price of the farm products than by the adaptation of the soil to crops.

The farms, as a rule, are well improved. Most of the houses and barns are in good repair, and there is a general appearance of prosperity. The farms are fenced and cross fenced, mostly with barbed wire, though many of the alfalfa and corn fields are inclosed with hog-tight woven-wire fencing. Four-horse teams perform most of the farm work. A few tractors are used during the plowing season, and modern labor-saving machinery is in general use. Most farms are equipped with manure spreaders, grain drills, mowers, rakes, binders, riding cultivators, and disk harrows, and a few farmers have corn binders and hay balers. The more expensive machinery is sheltered.

Practically no commercial fertilizer is used. Barnyard manure is applied, but the supply is seldom sufficient for best results. On most tenant farms little care is taken to apply the manure where it is most needed and the land in the immediate vicinity of the barnyards often receives the larger quantity.

According to the Federal census, 94.4 per cent of the county was in farms in 1920, and the average size of the farms was 190.4 acres. About 90.7 per cent of the farm land was improved. The farms vary greatly in size, but most of them range from 160 to 320 acres. Some of those in the more poorly drained parts of the Platte River bottoms, however, exceed a square mile in extent.

The 1920 census shows that 56.9 per cent of the farms are operated by owners and 42.3 per cent by tenants. The cash system of rental predominates. Under this system the renter pays from $4 to $10 an acre for the use of the farm land. Pasture rent is commonly paid in a lump sum, and the average rate to the acre is difficult to determine. On a few farms the renter is allowed the use of the pasture land without additional charge. Under the share-rent contracts, the tenant usually furnishes all equipment, labor, and seed, and receives from two-fifths to one-half of the crops.

Selling prices of land in Butler County range from about $50 to $200 an acre, depending on the surface features, drainage, character of the soil, improvements, and location with respect to markets. The average price for the county is probably about $150 an acre. The highest-priced land is that consisting of the Marshall, Hastings, Crete, and Waukesha soils, and the lowest priced is areas of river wash, the more poorly drained parts of the flood plains, and the more sandy soils of the Sparta and Valentine series.

SOILS

The soils of Butler County owe their distribution and most striking characteristics to three main factors: Namely, the character of the geologic formations from which they have developed; the soil-

forming processes acting on these formations; and the length of time the processes have acted without disturbance.

When the soils were beginning to form, the parent geologic formations were everywhere the controlling factor in determining their character. Subsequently, however, the upper part of the formations, being exposed to weathering, was gradually altered by the soil-forming processes, including leaching, oxidation, aeration, the accumulation of organic matter, and the development of a soil profile, and the geologic formations were thus converted into soils. The degree of alteration depended on the topographic and drainage conditions under which the soil-forming processes were forced to act, the length of time they acted, and the relative resistance of the geologic formations to their action. The alteration, therefore, was not uniform in all parts of the county, and the soils have reached various stages of development.

Those soils which still retain many of the characteristics common to the formations from which they were derived may be regarded as imperfectly developed. In contrast to them are the soils in which the parent formations have been so altered by weathering that they are now of minor importance in influencing the character of the soils. Such soils may be regarded as well developed, as their characteristics are largely the result of the soil-forming processes and not of the characters of the geologic formations. There are, therefore, in Butler County two broad groups of soils; namely, imperfectly developed soils and well-developed soils. The latter group occupies much the larger part of the county.

In the well-developed soils of Butler County the most pronounced characteristics are the result of the prevailing climate and vegetation. The climate is temperate and humid. The county is in the tall-grass prairie region of the United States, and the annual decay of the luxuriant grassy vegetation under the moderate climatic conditions has resulted in the formation of large quantities of well-decomposed organic material and in the retention of this material by the soils. All well-developed soils, therefore, have dark-colored or almost black surface soils. They may differ, however, in one or more other respects. As precipitation of the region is uniform, it can not be used in explaining the existing differences in the soils. However, the surface features control the quantity of water entering the soil or standing on its surface and at different periods of time the soils have been subject to varying conditions of moisture.

On the basis of differences in the soil profile, the well-developed soils of Butler County may be separated into several subgroups, in each of which the soils owe their characteristics largely to the moisture conditions.

In the first subgroup are those soils which have developed on flat, gently undulating, or moderately rolling surfaces. They have sufficient slope to afford ample surface drainage and to prevent excessive accumulations of moisture but not enough to promote erosion. The topsoils are friable and consist of three well-defined layers. The upper one is loose, structureless, mulchlike material, in few places exceeding an inch in thickness. It is dustlike when dry. The second layer is laminated, the structure particles of the soil consisting of thin, horizontal, overlapping, disklike plates. The laminated layer

is from 2 to 5 inches thick. The laminae are very fragile. The lower topsoil layer is decidedly granular. It is 15 or 20 inches thick and continues to an average depth of 2 feet. The structure particles consist of small, rounded or subangular aggregates varying from one-sixteenth to slightly more than one-fourth inch in diameter. The larger aggregates are most abundant in the lower part of the layer. The granular material may or may not be columnar. The three topsoil layers are ordinarily similar in texture, being composed largely of silt and very fine sand. They are rich in organic matter and are prevailingly dark in color. The distribution and stage of decomposition of the organic constituents is not uniform, and the intensity of the dark color varies slightly in the different layers. The laminated layer is the darkest and contains the largest quantity of thoroughly decomposed carbonaceous material. Its color remains constant when the soil material is pulverized, indicating that the organic matter is thoroughly mixed with the mineral soil particles. The structureless mulchlike covering has the lightest color. The organic constituents are very abundant and are uniformly distributed throughout the layer but are not all thoroughly decomposed and the layer is dark grayish brown or grayish brown. In the granular layer decomposition of the plant remains is complete, but the organic matter is not sufficiently abundant to thoroughly permeate the structure particles, as in the overlying layer, and occurs largely as a film or coating on the surfaces of the granules. The film is thickest in the upper part of the layer, making a natural exposure of that part as dark and apparently as rich in organic matter as the overlying layer. The granular material, however, when crushed becomes lighter in color than material similarly treated from the laminated layer, indicating a lower organic-matter content to the unit of soil volume. The organic film decreases in thickness with depth and the lower part of the granular layer is dark grayish brown or, when crushed is grayish brown.

The fourth layer, or the upper part of the subsoil, is the layer of maximum compaction. It is invariably denser than the other layers. It is from 10 to 14 inches thick and continues to an average depth of about 30 inches. The degree of compaction varies a little in different soils, but the density is seldom pronounced and in most places is scarcely noticeable, except by comparison with that of other layers. The material is grayish brown, dark grayish brown, or reddish brown. It is more or less cloddy and ordinarily can be broken into cubical or prismatic structural units, few of which exceed three-fourths inch in their longer or vertical dimension. The material contains less organic matter than the overlying layers. The organic constituents, as in the granular layer, occur largely as a film or coating on the surface of the structure particles, but the film is very thin, as is evidenced by the light color of the material. Beneath the layer of maximum compaction the subsoil merges gradually through transitional material into the unweathered parent formation which generally occurs at a depth of 4 or 5 feet. The transitional material and parent formation may or may not be calcareous.

The soils of this subgroup contain worm casts and elongated, twisted, rodlike forms in all layers beneath the laminated one, especially in the granular layer. The worm casts are more or less spheri-

cal and are about one-sixteenth inch in diameter. They may be grouped in rounded clusters of as many as 25 individuals or they may occur as fillings in old root or insect cavities. The rodlike forms, often called borings, are also fillings in root or insect cavities and may at one time have consisted partly of worm casts. Most of the borings are either lighter or darker than the layer in which they occur, depending on whether the material composing them was derived from underlying or overlying soil layers.

The well-developed soils, characterized by the profile described, include those of the Marshall, Carrington, and Waukesha series. The soils of the first two series occupy upland positions and those of the last occur on well-drained terraces. All have been formed under conditions of good surface and internal drainage. Percolating waters have removed the readily soluble salts from the weathered soil section and have prevented the development of a zone of lime accumulation. Percolating water, however, has not been sufficiently abundant to carry much of the finer-textured surface particles into the lower soil layers, and the subsoils are only faintly more compact than the overlying layers.

The Marshall soils are stone free, having weathered from silty loesslike formations. They have more or less brownish subsoils. The soils of the Carrington series have weathered from glacial formations and contain rock fragments in the form of pebbles or small bowlders. The pebbles and bowlders, however, are not sufficiently abundant to influence the character of the soil and in many places are so few as to be scarcely noticeable. The subsoils in the Carrington soils appear to be more oxidized and commonly have more of a reddish or yellowish-red cast than those of the Marshall soils. The Waukesha soils are separated from the Marshall in mapping, chiefly on account of their lower topographic position. Being on terraces the Waukesha soils are more favorably situated to receive moisture and surface wash from the higher slopes than are the Marshall soils. They are, therefore, considered slightly superior to the Marshall soils for general farming. The Waukesha soils are similar to those of the Marshall series.

Another subgroup of well-developed soils in Butler County includes those of the Hastings, Crete, and Hall series. These soils occupy more nearly level situations than the Marshall and Carrington soils, and surface drainage, although adequate, has been slower. More of the surplus moisture has passed downward through the soil and has carried larger quantities of the finer-textured surface soil particles into the underlying layers. The surface soils are similar to those of the Marshall, Carrington, and Waukesha series, but the subsoils are very different. Moreover, the differences become increasingly pronounced as the moisture supply under which the soils developed becomes greater.

In the Hastings soils, which have probably developed under only slightly greater moisture supply than the Marshall, the subsoils resemble those of the Marshall series more closely than do those of the Crete and Hall soils. The county, however, is in a region where very slight differences in the soil moisture apparently produce marked differences in the character of the subsoils. The upper part of the subsoil of the Hastings soils, although otherwise similar to the cor-

responding layer in the Marshall soils, is considerably more compact, probably owing to the greater translocation of surface material by percolating waters. It has not attained claypan characteristics, however, and the material composing it is sufficiently friable to be easily crushed between the fingers.

In the Crete soils of the nearly level uplands and in the Hall soils which occupy practically level terraces, the moisture supply under which the soils developed was undoubtedly much greater than in the Marshall soils and somewhat more abundant than in the Hastings soils. The downward translocation of much fine-textured surface material through the agency of percolating waters has made the upper part of the subsoils decidedly compact. In fact, these layers are almost of claypan structure, being composed largely of dense, impermeable clay. The color is similar to or only slightly darker than that of the corresponding layer in the Marshall and Hastings soils. It is generally brown or dark grayish brown. The clay is rather massive in appearance, although in many places it seems to have developed definite structure and can be broken into more or less cubical clods from three-fourths to 1 inch in their longer, or vertical, dimension. It is extremely difficult to reduce the clods by pressure with the hands. The zone of maximum compaction varies somewhat in thickness but continues to an average depth of about 3 feet in the Hastings and Crete soils and of about 30 inches in the soils of the Hall series.

Beneath the zone of maximum compaction in the Hastings, Crete, and Hall soils is light grayish-yellow or almost white loose, floury silt. The material is calcareous and below a depth of 5 feet is similar to the unweathered loessial formation from which the soils have developed. The upper 4-inch to 12-inch layer, however, or that part immediately below the zone of maximum compaction, commonly contains more free lime than the remainder, especially in the Crete and Hall soils, and may be regarded as a layer of lime accumulation or a lime zone. It was probably formed by the solution and translocation of carbonates in percolating waters from the overlying layers. The lime zone, although fairly well developed in the Crete and Hall soils, is much less pronounced, and is in places absent, in the soils of the Hastings series. It does not occur in the Marshall, Carrington, and Waukesha soils.

The factors controlling variations in the degree of development of the lime zone in the soils of Butler County are not clearly understood. The fact that the lime zone is most pronounced in soils with the densest layers of maximum compaction indicates a relationship between the degree of compaction in the upper part of the subsoils and the stage of development attained by the zone.

In the Crete and Hall soils, which have decidedly compact upper subsoil layers, the dense clay undoubtedly restricts the movement of percolating waters and, since the moisture supply is not excessive, the clay probably prevents the penetration of sufficient water to leach the carbonates from the layer beneath.

In the Hastings soils the moisture has apparently been less abundant than in the Crete and Hall soils. The upper subsoil layers of the Hastings soils, however, are only moderately dense and have probably allowed more moisture to penetrate into the underlying lime zone than penetrated in the Crete and Hall soils. The develop-

ment in the zone of lime accumulation is less pronounced. The Marshall, Carrington, and Waukesha soils were probably developed under a somewhat lower soil-moisture supply than the Hastings, Crete, and Hall soils, but their upper subsoil layers are friable, allowing free water percolation and the consequent removal of the carbonates.

A third subgroup of well-developed soils in Butler County includes the soils of the Butler and Scott series. They occupy depressed, ordinarily basinlike situations, throughout the more nearly level uplands. In few places is surface drainage established. In many of the basins water accumulates and remains on the surface for periods ranging from a few days to several weeks after heavy rains. The basins, therefore, are alternately wet and dry but are dry the greater part of each year. The soils have been subjected to surplus moisture in larger quantities and for longer periods of time than those of any series previously mentioned. Percolation, therefore, has been more continuous, and its results are more pronounced.

The topsoils are extremely variable. In the deeper basins, or parts thereof, the topsoils in few places exceed 6 or 8 inches in thickness. They are friable or only moderately compact, consisting chiefly of laminated silt or silty clay loam. In the shallower basins the topsoils in many places attain a thickness of 15 or 18 inches and have three layers, a structureless, a laminated, and a granular layer, similar in texture and structure to the corresponding layers in the Marshall, Hastings, and Crete soils. The color of the topsoils ranges from dense black to light gray. The lighter shades result from the presence of almost white, loose, floury silt which occurs in greater or less abundance in all places. It may be a mere sprinkling, scarcely noticeable on the surfaces of almost black structure particles or it may be concentrated, especially in the lower part of the topsoil, forming a white, silty, laminated layer from 2 to 4 inches thick. The lighter shades in the topsoils of the Scott and Butler soils seem to be coextensive with those areas subjected to the greatest excess of moisture.

Beneath the variable topsoils is dense, structureless clay. This is the layer of maximum compaction and is a true clay pan, being considerably more compact than the corresponding layer in the Crete and Hall soils. The clay pan varies from almost black to steel gray or bluish gray. The lighter colors prevail in the lower situations, where much of the clay is mottled with rust-brown stains, streaks, and splotches. The steel-gray clay pan contains scattered round, black and hard concretionary forms from one-eighth to slightly more than one-fourth inch in diameter. Both the dark and lighter-colored clay pans are extremely plastic when wet but very hard, tough, and resistant to penetration when dry. When dry they check and crack severely, owing to the shrinkage of the clay.

The clay pan is underlain by a 10-inch or 12-inch layer of light grayish-brown or grayish-yellow loose structureless silt. The presence or absence of lime in this light-colored layer apparently depends on the quantity of excess moisture to which the soils have been subjected. The layer is invariably highly calcareous where it underlies a dark clay pan, the lime existing chiefly in numerous hard, irregular concretions from one-eighth to one-half inch in diameter. Beneath a steel-gray or bluish-gray clay pan lime rarely, if ever, occurs.

The light-colored structureless silt is underlain by loess which contains no lime to a depth of 10 or 12 feet but which is otherwise similar to the loess underlying the Marshall, Crete, Hastings, Hall, and Waukesha soils.

The characteristics of both the Butler and Scott soils are the same as those just described. All features described, however, are not common in the soils of both series.

The Butler soils occupy the more shallow basins. They are transitional in their drainage and development between the Crete and Scott soils. Moisture, although abundant, has not been so excessive as to penetrate the dense clay in sufficient quantities to remove the carbonates from the underlying layer. The Butler soils have pronounced zones of lime accumulation in their lower subsoil layers. They have thinner and commonly less granular topsoils than the Crete soils, and the upper subsoil layers or clay pans are almost black and are considerably more compact than the corresponding layer in the Crete soils.

The Scott soils occupy the deeper basins and have been subjected during their formation to complete saturation for a considerable part of each year. Their surface soils are much thinner than those of the Butler soils. Poor aeration and excessive leaching have given the soil in the clay pan layer a steel-gray or bluish-gray, more or less mottled color. The leaching has been sufficient to remove all readily soluble lime carbonate from the layer beneath.

In the group of imperfectly developed soils the characteristics of the soils are determined to a considerable extent by the character of the materials from which the soils were derived. The weathering agencies have either not had time to develop a mature soil, or the weathered soil material has been removed by erosion about as fast as it has been formed, leaving either the parent material or only partly weathered soil at the surface. The group of imperfectly developed soils may be separated into subgroups on the basis of the force, or group of forces, which has been instrumental in preventing development of more mature soils.

In the first subgroup are those soils in which full development has been retarded largely by erosion. The Knox soils are the only representatives of this subgroup in Butler County. They occupy steeply sloping or hilly surfaces where more or less constant erosion has prevented much accumulation of organic matter in the surface soils. Moreover the rapid run-off has removed the products of soil weathering almost as fast as they were formed, and fresh unweathered material is kept either constantly exposed or is within a few inches of the surface. The surface soils are grayish brown or light grayish brown, semigranular, and in few places more than 8 inches thick. They rest either on only slightly modified parent material or on the parent material itself. The parent material is light-gray, loose, and highly calcareous silt which is uniform in texture, color, and consistence throughout the loessial formation. The Knox soils differ from those of the Marshall series in their thinner and lighter-colored surface soils and in the absence of definite zones or layers in their profiles. They may be regarded as an eroded phase of the Marshall soils.

The second subgroup of imperfectly developed soils includes those which have been derived from parent materials that are more resistant to the action of soil-forming agencies than is the loess underlying the Knox soils. This subgroup includes the soils of the Valentine and Sparta series, all of which have developed from accumulations of wind-blown or water-laid quartzitic materials, chiefly gray sand of fine or medium texture. Some of the soils, however, especially those of the Sparta series, contain considerable gravel in their lower subsoil layers. Most of the parent materials are of recent origin or have been so continuously shifted by wind and water that they have accumulated very little organic matter. The materials are loose and incoherent. There is no surface drainage, but the porous sand or gravel has allowed excessive leaching. The soils derived from these coarse-textured deposits are devoid of definite zones or layers and are very poor in lime. The surface 4 or 5 inch layer of the sandy or gravelly material generally contains a small quantity of organic matter and is slightly darker than the rest of the material. The organic-matter content, however, is in no place sufficient to prevent soil blowing when the protective vegetation is destroyed. All of the soils are similar in their profile characteristics and are differentiated in soil mapping on the bases of surface relief and the manner in which the parent materials have accumulated.

The Valentine soils are gently undulating, choppy, or hummocky, and are characterized by low, rounded knolls and ridges with intervening shallow depressions. They ordinarily occupy upland or slope positions, though they may occur on terraces. In the latter positions they plainly show the effect of wind action, and their surface relief is invariably less even than that of the strictly alluvial soils. The sand of which they are largely composed was apparently derived, in part at least, from sand pockets and sheets beneath the loess. These sheets have been exposed in several places by erosion.

The Sparta soils average more nearly level than those of the Valentine series. They occur entirely on terraces or bench lands along Platte River. The parent materials consist of stream sediments deposited when the stream was flowing at a higher level. The sediment is of coarser texture than that from which the Valentine soils were derived. In many places it contains considerable gravel. The greater part of the sediment probably came from regions to the west.

The O'Neill soils of the sandy or gravelly terraces are also included in the subgroup of imperfectly developed soils. The O'Neill soils have developed under conditions more favorable to the accumulation of organic matter than have the Valentine and Sparta soils. The surface soils are somewhat more stable and are considerably darker than those of other members of the group, locally being very dark grayish brown. The subsoils are similar to those of the Sparta soils.

The third subgroup of imperfectly developed soils includes those of the Judson series. The Judson soils are young soils and consist of materials recently removed from the uplands by surface wash or colluvial action and deposited near the base of the more gradual slopes, on narrow valley floors, or on gently sloping terraces. The deposits are very dark, having been derived chiefly from dark-colored

upland soils. The soils derived from these deposits are very dark grayish brown or black, have no definite structure, and are very uniform in color and texture to a depth greater than 4 or 5 feet. They have been leached of their lime carbonate.

The fourth subgroup includes the remainder of the imperfectly developed soils in Butler County. It comprises the Lamoure, Wabash, Cass, and Sarpy soils, all of which occupy flood-plain positions along streams and owe their imperfect development both to poor drainage and to the youth of the flood-plain sediments from which they are weathering. The moist conditions prevailing in the flood plains have especially favored an accumulation of organic matter, and all the soils, except those from the most recently deposited alluvium, have dark-colored surface soils. The parent materials have not developed definite zones or layers. Oxidation and aeration, in most places, have been greatly retarded by excessive moisture, and in many places the surface soils rest directly on the unweathered or only slightly weathered parent alluvial sediments.

Those soils which have weathered from fine-textured sediments consisting largely of silt and clay are classed with the Lamoure and Wabash series. They have friable, almost black surface soils, 12 or 14 inches thick. The subsoils are moderately compact on account of a rather high clay content. Those of the Wabash soils are similar to or only slightly darker in color than the surface soils. They are very poor in lime. In the Lamoure soils the subsoils are light grayish brown, dark grayish brown, or mottled gray and white. They contain an abundance of lime in concretionary and disseminated form. Both the Lamoure and Wabash soils have more or less granular surface soils, but their subsoils are practically devoid of structure.

The coarser-textured flood-plain sediments of Butler County consist largely of sands and gravels and have been mapped in the Cass and Sarpy series. The Cass soils have accumulated considerable organic matter. Their surface soils are very dark grayish brown or almost black and are from 6 to 12 inches thick. The Sarpy soils have weathered from more recently deposited sediments and are poorly supplied with organic matter, their surface soils being very thin and light in color. The subsoils of both the Cass and Sarpy soils are composed largely of loose gray sand and gravel, the latter constituent commonly becoming more abundant with depth. The soils may or may not contain lime, but if present the carbonates are in finely divided form and are evenly distributed throughout the entire soil.

In addition to the soil series previously described, is river wash, a miscellaneous material not classed in any series. It occurs on islands, bars, and flats within and adjacent to the stream beds. River wash, in Butler County, is composed largely of loose heterogeneous mixtures of gray sand and gravel.

Each soil series includes soils which are similar in their more important characteristics, with the exception of the texture of the surface soil or the relative proportion of different-sized mineral particles present. Soils having uniform textures in their surface soils are called soil types. A soil series, therefore, may include several soil types, which are the units in soil mapping. In Butler

County each of the soil series previously described includes one or more soil types.

In the following pages of this report the various types of soil mapped in Butler County are described in detail and are discussed in their relation to agriculture; their distribution is shown on the accompanying soil map; their acreage and proportionate extent are given in Table 3:

TABLE 3.—*Acreage and proportionate extent of soils mapped in Butler County, Nebr.*

Type of soil	Acres	Per cent	Type of soil	Acres	Per cent
Marshall silt loam	176,384	46.8	Bremer silt loam	1,920	0.5
Hastings silt loam	51,200	13.6	Crete silt loam	6,016	1.6
Carrington silt loam	21,376	5.7	Cass fine sandy loam	4,928	1.3
Carrington loam (shallow phase)	2,176	.6	Cass silt loam	1,792	.5
Knox silt loam	11,776	3.1	Cass sandy loam	576	.2
Waukesha silt loam	22,400	6.0	Sparta sand	2,816	.7
Waukesha sandy loam	1,344	.4	Sarpy sand	1,280	.3
Judson silt loam	16,704	4.4	Valentine loamy sand	1,408	.4
Hall silt loam	1,600	.4	Butler silt loam	8,000	2.1
Lamoure silt loam	14,144	3.8	Scott silt loam	5,696	1.5
Lamoure loam	4,416	1.2	River wash	256	.1
O'Neill sandy loam	9,728	2.6			
Wabash silt loam	8,384	2.2	Total	376,320	

MARSHALL SILT LOAM

The surface soil of Marshall silt loam is dark grayish-brown, very dark grayish-brown, or almost black friable silt loam from 6 to 15 inches thick. The upper part of the subsoil is grayish-brown slightly more compact silt loam about 12 inches thick. Below a depth of 26 inches is yellowish-brown friable silt loam which becomes lighter in color and looser with depth and grades, at a depth of about 36 inches, into grayish-yellow or almost white floury silt which is rich in lime and uniform to a depth of 5 or 6 feet. The surface soil contains a thick mat of roots of prairie grass. The lower part of the surface layer is decidedly granular. The material has a high organic-matter content, which accounts for its dark color and smooth, velvety feel. The quantity of organic matter decreases with depth, is only moderate below a depth of 18 inches, and is very small below a depth of 6 feet.

Marshall silt loam is fairly uniform throughout its area in Butler County. The principal variations are slight differences in the thickness of the surface soil, owing to local variations in the relief. The only subsoil variation of importance is in the more rolling or steeply sloping areas where the upper part of the subsoil seems to lose its slight compaction and differs little in density from the surface soil.

Most of this soil occurs on undulating or very gently rolling surfaces where natural drainage is good. Locally, the slopes become moderately steep. In these situations erosion is rather severe, and Knox silt loam is gradually encroaching on the areas of Marshall silt loam.

Marshall silt loam is the most extensive upland soil in Butler County, covering 46.8 per cent of the county. It occupies practically all the gently undulating or rolling areas on divides and slopes

throughout the loess-covered part of the county and occurs on the broader loess-covered divides in the drift-hill area. Practically all of the soil is tillable, and about 90 per cent of it is under cultivation. The remainder is used for pasture and hay land. The native vegetation in virgin areas consists of a thick growth of prairie grasses, chief among which are big bluestem and little bluestem. The former is most abundant in the more eroded sections and the latter predominates in the smoother areas. These grasses provide excellent pasturage during the spring and fall, when moisture is most abundant, but in midsummer they sometimes wither and can not be depended on for good grazing during July and August.

On the cultivated areas all crops common to the region are grown, but corn, wheat, oats, and alfalfa occupy the largest acreages. Many farmers fatten a few carloads of cattle each year for market, and hogs are raised on every farm.

No commercial fertilizers are used in growing the staple crops, but all available barnyard manure is applied.

Crop rotation and seed selection are not systematically practiced, although the more progressive farmers use seed adapted to the region and rotate their crops with reasonable regularity. The most common rotation is corn 1 or 2 years, followed by oats and wheat, 1 year each, and alfalfa 5 or 6 years. Alfalfa is not well adapted to short rotations, and some farmers are beginning to use sweet clover in its place. On tenant farms, corn or wheat is often grown for 3 or 4 years in succession on the same ground.

Variation in crop yields on this soil is very slight from year to year, except in years of adverse climatic conditions, as in 1924 when the growing season was unusually cold and wet. The ordinary yield of corn is about 40 bushels to the acre, of wheat 25 bushels, of oats 30 bushels, and of alfalfa hay 3 or 3½ tons from 3 cuttings. Native hay yields from one-half to three-fourths ton to the acre during average years. The larger yields are commonly obtained when the crop is cut late in the season. Late-cut hay is also considered to have a higher feeding value than that cut rather early in the season.

The current selling price of Marshall silt loam varies from $125 to $200 an acre, depending on the relief, improvements, and location with respect to markets.

HASTINGS SILT LOAM

The surface soil of Hastings silt loam is similar to that of the Marshall soils, except that it is, on the average, somewhat deeper, locally continuing to a depth of 18 or 20 inches. The upper part of the subsoil is slightly more compact than in the Marshall soils. It is about 12 inches thick and consists of heavy brown silt loam containing a rather high percentage of clay. The material, however, is only moderately compact and does not attain sufficient density to interfere with root development. It is easily broken down between the fingers into a loose granular mass. The lower part of the subsoil begins at a depth of about 3 feet and continues to the underlying loessial formation from which the soil has weathered. It is light yellowish-brown, loose, floury silt with a high lime content. It greatly resembles unweathered loess but averages slightly darker and commonly contains more lime. It merges with the loess at a depth of about 4 feet.

The surface soil of Hastings silt loam is everywhere well supplied with organic matter, and the soil as a whole is very uniform throughout the area of its occurrence in Butler County. The few variations are largely the result of differences in the surface relief. In the more strongly undulating areas the upper part of the subsoil is much more friable than typical and closely resembles the corresponding layer in the Marshall soils. Since the relative compaction of this layer is one of the determining factors in separating Hastings silt loam and Marshall silt loam in mapping, it is necessary in many places to draw arbitrary lines between the two soils on the map. Another variation occurs around the margins of areas of the Crete or Butler soils and in the flatter situations where surface run-off is unusually slow. In such places the upper part of the subsoil is much more compact than typical, greatly resembling the corresponding layer in Crete silt loam. These variations, however, are simply transitional conditions between merging soil areas and are not sufficiently extensive or important to indicate on the soil map.

Hastings silt loam is extensive in the south-central, southwestern, and west-central parts of Butler County. Some of the largest areas are in Ts. 13 and 14 N., R. 3 E. Typical areas of the soil are between Surprise and Rising City, north of Rising City, and west of David City. Few of the individual areas exceed 2 or 3 square miles in extent.

This soil occurs on the flatter areas where drainage channels are poorly established. In most areas there is sufficient slope, however, to slowly remove surplus surface moisture into some shallow draw or basinlike depression occupied by other soils. The upper part of the subsoil is not sufficiently dense to prevent downward water movement, and internal drainage is good.

Hastings silt loam is important agriculturally in Butler County. Its high fertility, silty, stone-free character, and smooth surface adapt it well to all crops common to the region. Practically all of the soil is under cultivation, except a few small patches used for farm buildings, feed lots, and pastures for the work animals and milk cows. The native vegetation consisted chiefly of big and little bluestem grasses, together with small areas of grama grass. These grasses afford excellent pasturage during most of the summer.

Corn, wheat, oats, and alfalfa are the leading cultivated crops. Cattle feeding is practiced rather extensively, and hogs are raised on every farm.

Crop yields are about the same as on Marshall silt loam, and the soils are managed in the same way. Hastings silt loam is preferred by most farmers, however, on account of its smoother surface and greater freedom from erosion. It has a slightly higher sale value than Marshall silt loam.

CARRINGTON SILT LOAM

The surface soil of Carrington silt loam is dark grayish-brown or brown silt loam, 12 inches thick. It is underlain by brown, moderately compact silty clay, having a more or less cloddy structure. This material continues to a depth of about 30 inches and rests on the parent material of brown or brownish-yellow silty clay containing varying quantities of sand, gravel, and a few small bowlders, and

mottled with rust brown and bluish gray. At a depth of about 43 inches, the parent material contains lime in streaks, splotches, and concretions.

The organic-matter content of the surface soil is ordinarily good, especially in the more nearly level areas or on more gradual slopes, but is deficient in some places.

This soil presents a few variations from the profile as described. In some localities the material, between depths of 6 and about 20 inches, is coffee-brown plastic silty clay. This layer grades into dark grayish-brown material of similar texture but mottled with light brown and yellowish gray. The parent material begins about 3 feet beneath the surface, except in eroded places where it is much nearer the surface. On a few of the steeper hillsides the surface soil and upper part of the subsoil have been entirely removed by erosion, exposing the sandy gravelly clay from which the soil has weathered. Another variation from typical is characterized by a surface soil of friable silt loam about 10 inches thick. The upper part is dark brown and the lower part is brown. The next lower layer is reddish-brown, moderately compact silty clay which continues to an average depth of 24 inches. Beneath this layer is yellowish-brown silty clay mottled with bluish gray. Locally, where erosion has been rather severe, the surface soil described is reddish brown.

Carrington silt loam occurs chiefly southeast of Brainard, although small areas occupy the lower parts of slopes bordering the loess hills in the northeastern part of the county, wherever glacial material is exposed by erosion. Most of the latter areas are narrow disconnected strips separated by colluvial deposits derived from the higher-lying loessial soils. Some of them are too small to indicate on the map.

Areas of this soil are gently rolling or hilly. Most areas are thoroughly dissected by numerous steep-sided drainage ways, separated by narrow well-rounded divides.

This soil has weathered from glacial deposits composed of a mixture of clay, sand, and gravel, together with a few small bowlders. It occurs only where erosion has removed the overlying loessial formations and exposed the glacial material to weathering. In many places loessial soils still cap the higher divides within areas of Carrington silt loam.

Drainage is everywhere good. On the steeper slopes surface runoff is rapid, and erosion is severe, in many places forming deep gullies.

About 75 per cent of this soil is under cultivation. The remainder, including the more severely eroded and rougher areas, is used for pasture and hay land. The native vegetation consists principally of big bluestem and little bluestem grasses. The latter species prevails on the high, more eroded hills and steeper slopes. The former predominates on the more nearly level area and is the principal hay grass. In addition to these grasses the soil supports shoe string, sumac, blazing star, wild ground cherry, articoke, and prairie clover. Scattered trees, chiefly oak, elm, ash, box elder, and cottonwood, are along many of the streams. Oak does well and is mixed with other trees throughout the southeastern part of the county.

In the cultivated areas, corn, wheat, and oats are the leading crops. Definite crop rotation is followed by only a few farmers. The general tendency is to plant corn for from 2 to 4 years, oats 1 year, and wheat 2 years, then again to plant corn. Occasionally the land is seeded to clover or alfalfa. Clover is usually left for 2 or 3 years and alfalfa for 7 years or more.

Fall plowing is general. The soil is easy to handle but requires more careful management than soils of the Marshall and Hastings series, on account of its slightly higher clay content. It should not be cultivated when either extremely moist or dry.

Crop yields vary considerably, depending on the season and the care used in handling the land. The usual yield of corn is about 30 bushels to the acre. Wheat, the chief cash crop, yields about 20 bushels to the acre. Oats do well on this soil, yielding about 30 bushels to the acre. The yield of native hay is about three-fourths ton to the acre.

The current sale value of Carrington silt loam ranges from $85 to $125 an acre. The price is controlled largely by the location, surface features, and improvements.

CARRINGTON LOAM, SHALLOW PHASE

The surface soil of Carrington loam, shallow phase, is dark grayish-brown friable loam, 15 inches thick. The subsoil is friable brown silt loam or loam in the upper part and faintly compacted brownish-yellow silt loam below a depth of 20 inches. It merges with the parent material about 2½ feet beneath the surface. The lower part of the subsoil is slightly limy, and the lime content increases with depth. The parent material is composed largely of a heterogeneous mixture of silt, clay, and gravel and contains streaks of white lime varying in width from 1 to 2 inches. Most of the streaks are bordered on both sides by narrow bands of reddish-brown or brown material. These bands seem to be unusually rich in iron oxides and many of them contain numerous rust-brown semihard concretions. The surface is strewn with numerous waterworn rock fragments and small granite bowlders, the latter ranging in diameter from 6 inches to more than 2 feet.

This soil occupies steeply rolling or hilly areas where erosion has removed the loessial soils and exposed the underlying glacial deposits to weathering. Its total area in Butler County is small. It occurs chiefly on the sharper and more eroded divides or on lower and steeper slopes throughout areas of Carrington silt loam.

All of this soil is included in pasture and hay land. The native grasses include little bluestem, bunch grass, grama grass, and some buffalo grass. These grasses do not form a solid vegetable covering but are rather patchy in growth, and probably 30 per cent of the soil is devoid of vegetation. Scrub timber, consisting chiefly of bur oak, occurs in almost pure stands on many of the higher ridges and steeper slopes.

KNOX SILT LOAM

The surface soil of Knox silt loam is dark grayish-brown or yellowish-gray silt loam 4 inches thick. It is underlain by pale-yellow, loose, floury silt or very fine sandy loam which is uniform to a depth

of 3 or 4 feet. The surface soil is very poor in organic matter, and the subsoil is almost devoid of that material. Both surface soil and subsoil are rich in lime. The soil has weathered from loessial deposits under conditions of severe erosion. The rapid surface run-off has removed the products of soil weathering almost as fast as they were formed and has kept fresh, unweathered loess constantly exposed or within a few inches of the top of the ground. Knox silt loam in Butler County is simply loessial material, the surface of which, to a depth of a few inches, has been slightly darkened by organic matter. In many places the soil consists of unweathered loess from the surface down.

This soil occupies a narrow belt along the south bluffs of the Platte River Valley and borders a few of the steeper drainage slopes in the loess plains northwest of David City. It also covers a small area southeast of Abie, where it caps a high, severely eroded loess hill. The total acreage is approximately 18 square miles.

About 50 per cent of this soil, including areas subject to the least erosion, is cultivated, and the remainder is devoted to grazing. The cultivated areas are used chiefly for growing corn and wheat. These crops, however, are subject to more or less injury through soil erosion, and some of the land is being seeded to alfalfa or sweet clover in an effort to prevent washing. Both of the latter crops are well adapted to this soil, as they are good soil binders and add both nitrogen and organic matter.

Crop yields vary widely, depending on the rainfall and the care used in preventing erosion. Corn yields about 25 bushels to the acre, wheat from 12 to 18 bushels, and alfalfa 1 ton for each cutting. Alfalfa is usually cut three times during the season.

The native grasses on the uncultivated areas consist chiefly of little bluestem, together with some grama and buffalo grass. They afford good pasturage and, when cut for hay, yield from one-half to three-fourths ton to the acre. Native trees, principally ash, elm, and box elder, grow in ravines and on many of the steeper slopes.

The current value of Knox silt loam ranges from $50 to $80 an acre, depending on the location and relief. Most of this land, however, is sold in conjunction with better farming soils.

WAUKESHA SILT LOAM

The surface soil of Waukesha silt loam, to an average depth of 12 inches, is dark grayish-brown friable silt loam well supplied with organic matter. It is underlain by yellowish-brown or brown slightly more compact but friable silt loam which continues to an average depth of 30 inches. This material rests on grayish-yellow floury silt which continues without change to a depth greater than 4 feet. The light-colored silt is the parent soil material. The soil is very poor in lime, although the parent material is in most places more or less limy below a depth of 6 feet.

Waukesha silt loam is very fertile and, owing to its high organic-matter content, is very retentive of moisture. It is similar in its characteristics to Marshall silt loam. The lime content, although low, is sufficient to promote good plant growth.

The slightly compact layer immediately below the surface soil is not sufficiently dense to prevent free penetration of roots and mois-

ture. It is usually a little more compact in the more nearly level areas than elsewhere.

Waukesha silt loam occurs in areas of various sizes on well-drained terraces or benches throughout the larger stream valleys. Most of the terraces are well defined and lie several feet above overflow. However, some of those in the Big Blue River Valley are scarcely above the high-water level of the stream, and a few of the benches along the larger creeks are locally subject to inundation during periods of high water. The benches are smooth or very gently undulating and are from 50 to 100 feet below the general level of the uplands and from 3 to 20 feet above the flood plains of the streams. The transition to the flood plains is generally marked by a short, steep slope, although in some places the benches slope almost imperceptibly into the bottom lands. The slopes to the uplands are long and gradual.

Waukesha silt loam is very important agriculturally in Butler County. Its high organic-matter content, level surface, stone-free character, and silty texture make it well adapted to all crops common to the region. Practically all of it is under cultivation. Corn, wheat, and alfalfa are the most important crops. Their average yields, respectively, are 40 bushels, 20 bushels, and 3 tons of hay to the acre. Potatoes are grown only for home use.

This soil is easily maintained in good tilth. No commercial fertilizers are used, although barnyard manure is usually applied during the fall months to wheat land and during the spring to land used for corn.

The current sale value of Waukesha silt loam is from $175 to $200 an acre, the price depending largely on the improvements and location.

WAUKESHA SANDY LOAM

The surface soil of Waukesha sandy loam is dark grayish-brown, loose, friable sandy loam from 10 to 15 inches thick. It is fairly well supplied with organic matter and under field conditions appears almost black. The typical subsoil is brown, friable sandy loam to an average depth of 20 inches, below which is moderately compact sandy loam containing small quantities of clay. In many localities, however, the lower part of the subsoil remains friable and resembles the upper part except that it is slightly lighter in color. The surface soil and subsoil are not noticeably calcareous but do not appear to be deficient in lime.

This soil occurs on terraces or benches along streams. Most of it lies a few feet above the general level of Waukesha silt loam and is very well drained. It is inextensive in Butler County, the largest areas occurring a half mile south of Bellwood and in secs. 28, 29, and 32, T. 16 N., R. 1 E.

This soil is of little agricultural importance, on account of its small extent. It is very fertile, however, and all of it is under cultivation. It is well adapted to the growing of corn, oats, wheat, and alfalfa. Corn yields average 35 bushels to the acre, wheat 18 bushels, oats 25 bushels, and alfalfa 3 tons to the acre from three cuttings. The soil is not considered so well adapted to growing small-grain crops as the heavier-textured soils of the county, on account of its looseness and sandiness which favor wind erosion.

JUDSON SILT LOAM

The surface soil of Judson silt loam is very dark grayish-brown friable silt loam which is uniform to a depth of 36 or more inches. It is rich in organic matter but does not contain sufficient lime to effervesce when dilute hydrochloric acid is applied.

This soil occupies low terraces, colluvial slopes and fans, and sloping flood plains. In the latter situations it is subject to frequent overflow during seasons of heavy rainfall. Most of the soil occurs in belts from one-fourth to one-half mile wide, bordering intermittent streams. In a few places it occurs on level or undulating valley ridges which probably constitute remnants of recently deposited alluvium. Some of the largest areas are along Big Blue River and the principal tributaries to Platte River. Small areas occupy alluvial fans formed by the deposition of sediments near the mouths of streams issuing from the uplands. These areas lie slightly above the surrounding alluvial soils. Most of the areas of Judson silt loam are small.

Drainage is good. All of the soil has sufficient slope to remove the surface water rapidly and, although areas in narrow stream valleys are subject to overflow, the water quickly disappears when the streams subside.

Judson silt loam is one of the most productive soils of the county and withstands severe cropping without apparent injury. The larger areas are practically all under cultivation, but many of the smaller ones are used for hay and pasture land. All crops common to the region can be successfully grown. Corn, wheat, oats, alfalfa, and potatoes are the leading crops. Yields are about the same as on Waukesha silt loam and Marshall silt loam. Considerable organic matter is concentrated in this soil through surface wash from higher lands. In the summer of 1924 a few farmers reported a wheat yield of 50 bushels to the acre from fields previously used for alfalfa.

Current sale values are not available for Judson silt loam, as in very few places does the soil occupy more than a small part of a farm. Land values, however, are usually increased by the presence of Judson silt loam on the farms.

HALL SILT LOAM

The surface soil of Hall silt loam is very dark grayish-brown friable silt loam rich in organic matter. It is underlain, at a depth of about 12 inches, by dark-brown, almost impervious clay which continues to an average depth of 20 inches. The lower part of the subsoil is light-gray or yellowish-gray loose, floury silt. It is rich in lime, which seems to be most concentrated in the upper part, where it occurs as concretions, spots, splotches, and other visible forms. Below the layer of lime concentration the carbonates occur chiefly in finely divided form thoroughly mixed with the silt. The lower part of the subsoil, below a depth of 4 or 5 feet, merges with the unweathered, almost white silty parent loessial material. The soil differs from Waukesha silt loam in having a denser upper subsoil layer and a higher lime content in the lower part of the subsoil.

Hall silt loam occurs on high benches or terraces along Big Blue River and its tributaries. Areas are nearly level or undulating.

The soil is well drained, except in a few small depressions in which it is more or less alkaline.

The total acreage of this soil in Butler County is small. The most extensive development is west and south of Ulysses. Practically all of the soil is used for growing corn, wheat, and oats. It is retentive of moisture, and the compact layer in the subsoil is not sufficiently dense to prevent free root penetration. Crop yields compare favorably with those obtained on Waukesha silt loam, and the soil has about the same current sale value as the Waukesha soil.

LAMOURE SILT LOAM

Lamoure silt loam is a bottom-land soil. Its surface soil is black, heavy though friable silt loam, 15 inches thick. The subsoil is moderately compact silt loam or silty clay loam which continues to a depth greater than 4 feet. It is grayish brown to a depth of 4 or 5 inches but becomes lighter in color with increasing depth and is light grayish brown, in many places mottled with rust-brown, gray, and white streaks, in the lower part. The material is plastic and sticky when moist but becomes hard and brittle when dry. The entire soil has a high lime content, and numerous lime concretions occur in places in the subsoil. The surface soil is rich in organic matter.

This soil ranks third in acreage among the alluvial soils of Butler County. It occurs largely on the Platte River bottoms, where it occupies a belt, 1 or 2 miles wide, extending east and west across the county. Narrow necklike spurs at right angles to this belt extend into the terrace lands southeast of Bellwood and near Octavia.

Areas of this soil are almost level, except where they are modified by shallow depressions, old cut-offs, and stream channels. Drainage is poor. The water table remains permanently near the surface, and during seasons of abundant rainfall it rises sufficiently to produce small areas of swampy land. Even in dry years the subsoil remains very moist.

This soil is very strong and fertile, and where natural drainage is fair or good or where artificial drainage has been provided it is well adapted to all crops commonly grown in the county.

About 50 per cent of this soil is under cultivation. The remainder, including the more poorly drained areas, is used for pasture and hay land. The native vegetation includes a great variety of moisture-loving grasses, although big bluestem is the dominant hay grass.

This soil is well adapted to the growing of alfalfa on account of its high lime content. By carefully preparing the seed bed a good stand of alfalfa is usually obtained, and the crop yields from 2½ to 3½ tons to the acre each season. Wheat yields from 20 to 25 bushels, oats about 30 bushels, and corn from 40 to 50 bushels to the acre. The acreage devoted to oats is comparatively small, as only enough oats are grown to provide feed for the work animals. Both wheat and oats are more likely to make rank vegetative growth at the expense of the grain than they are on the better-drained soils of the county. The native hay yield ranges from 1 to 1½ tons to the acre, depending on the season.

This soil is sufficiently strong to withstand severe cropping without greatly decreasing its fertility, as it receives considerable organic

matter with the surface wash from higher lands. The limiting factors in crop production have been poor drainage and improper tilth, both of which are easily remedied.

With artificial drainage practically all of the soil could be placed under cultivation.

The current sale value of this soil ranges from $100 to $200 an acre, depending on drainage conditions, improvements, and location with respect to markets.

LAMOURE LOAM

The surface soil of Lamoure loam is dark grayish-brown, very dark grayish-brown, or black, friable loam 18 inches thick. The subsoil is light-gray friable heavy silt loam which grades, at a depth of about 30 inches, into grayish-white calcareous silt. The surface soil is rich in organic matter, but this material decreases with depth and is scarcely noticeable in the lower part of the subsoil.

This soil is fairly uniform throughout the area of its occurrence, although, in areas adjoining O'Neill sandy loam, the surface soil and subsoil to a depth of 30 inches are a little more sandy and low in lime than typical. Locally the substratum below a depth of 50 inches is almost white sand and gravel. These variations occupy only a small percentage of the soil and are not shown on the soil map.

Lamoure loam occurs on the flood plains of Platte River. It occupies a topographic position intermediate between that of the slightly higher-lying Lamoure silt loam and the lower-lying Cass and Sarpy soils.

Drainage is good during normal seasons. In wet years underdrainage is poor, although the soil as a whole is somewhat better drained than Lamoure silt loam.

All of this soil is under cultivation. It is very productive and is adapted to all crops commonly grown on Lamoure silt loam. In fact, the farmers show practically no preference between the silt loam and loam members of the Lamoure series. Both have about the same sale value.

O'NEILL SANDY LOAM

The surface soil of O'Neill sandy loam is friable, dark-brown or very dark grayish-brown sandy loam 12 inches thick. It contains an abundance of grass roots and is fairly well supplied with organic matter. The upper part of the subsoil is brown or yellow incoherent fine sand and gravel. The lower part of the subsoil, below a depth of about 24 inches, is gray medium or coarse sand and gravel. The surface soil, although fairly dark, is somewhat lighter in color than that of the O'Neill soils as mapped in other counties of Nebraska, probably on account of a sparser grass covering which has not afforded so much plant débris. Neither the surface soil nor the subsoil is calcareous. The soil is not retentive of moisture. It differs from the Waukesha soils chiefly in its sandier and less coherent subsoil.

This soil is fairly uniform throughout the area of its occurrence in Butler County. In one variation in the vicinity of Edholm the subsoil is much more coherent than typical and consists of friable reddish-yellow fine sandy loam which contains sufficient clay to re-

tain considerable moisture. This variation is more drought resistant than the typical soil.

O'Neill sandy loam occupies smooth or gently undulating terraces, chiefly in the Platte River Valley. It ranks fourth among the valley soils in total acreage. The largest area is south of Platte River and extends in an east-west direction across the county, as a disconnected belt from one-fourth to 1 mile in width.

Practically all of the soil is under cultivation, principally to corn. Small grains are not well adapted to this soil on account of its incoherent structure, low water-retaining power, and instability during dry windy periods. Some oats and wheat are, however, grown in the lower-lying and more protected situations where moisture conditions are most favorable. Crop yields vary widely, depending on the rainfall. Corn yields about 25 bushels to the acre, wheat from 10 to 18 bushels, and oats about 25 bushels.

The current selling price of this land is from $100 to $150 an acre. The price depends largely on the improvements and location.

The chief problems in managing this soil are the conservation of moisture and the prevention of wind erosion. These problems are being partly solved by planting the corn with a lister and by heavy applications of barnyard manure.

WABASH SILT LOAM

The surface soil of Wabash silt loam consists of very dark grayish-brown or almost black silt loam, from 10 to 15 inches thick. It contains large quantities of organic matter and in a few places a comparatively large percentage of very fine sand. The upper part of the subsoil is brown or dark grayish-brown heavy, slightly compact silty clay. Below a depth of about 24 inches, it grades into brown or brownish-drab silty clay which continues to a depth greater than 3 feet. Mottles of rust brown and bluish gray are common below a depth of 30 inches.

Most of this soil occurs on narrow stream bottoms in which the channel is very shallow and in which overflow is frequent. The surface is prevailingly smooth, although it is locally broken by slight depressions and old stream channels. In many places, small intermittent streams from the upland carry the run-off from large areas to the edge of the valley, where, on account of the decreased velocity of the current, the channels become filled with sediment and the water spreads over the surface. In some places the soil remains wet and boggy a large part of the year. In most places, however, water remains on the surface only a few hours after heavy rains.

Owing to the narrow linear shape of most of the soil areas, practically all of this soil is used for pasture land. It supports an excellent growth of nutritious grasses, chief among which are bluegrass and marsh grasses, the latter predominating on the more poorly drained areas. Narrow strips of scrub timber, consisting of ash, box elder, cottonwood, elm, and willow, with a few hackberry and linden trees, border many of the stream channels. None of the timber is of merchantable size but is of value for fuel and posts.

Wabash silt loam is one of the most productive soils in the county and in counties where it occurs more extensively is highly prized for general-farming purposes.

BREMER SILT LOAM

The surface soil of Bremer silt loam is very dark grayish-brown or black friable silt loam 6 inches thick. The subsoil is dark grayish-brown or drab, heavy silty clay or clay which, below a depth of 36 inches, is mottled with bluish-gray and rust-brown streaks and spots.

The surface soil is rich in organic matter, and the subsoil is well supplied with that material, especially in the upper part, as is indicated by the dark color. The soil is locally classed by the farmers as a gumbo soil. It is very poor in lime.

Bremer silt loam occurs in a few small areas on low terraces, chiefly within the Platte and Big Blue River Valleys. One of the largest areas is in the latter valley northwest of Ulysses and another is in the extreme northeastern part of the county, near Linwood. Many of the areas in the Platte River Valley border areas of Lamoure silt loam and a few which are too small to be shown on the soil map are mapped with the Lamoure soils.

The surface of this soil is almost level, and surface drainage is poorly established. The subsoil prevents free underdrainage, and the soil as a whole is rather poorly drained. Some of it is barely above overflow from the main streams.

This soil is of little agricultural importance in Butler County on account of its small extent and poor natural drainage. It is very fertile, however, and in other counties in Nebraska where it occurs more extensively and is artificially drained, is considered one of the most valuable farming soils. Even under the existing drainage conditions it is highly productive, and most of it is under cultivation to corn, oats, and wheat. Crop yields vary somewhat, depending on the season, but in average years corn yields from 40 to 50 bushels to the acre, wheat about 25 bushels, and oats 45 bushels. In unusually wet seasons crop yields are greatly reduced. A system of artificial drainage would insure more uniform returns.

CRETE SILT LOAM

The surface soil of Crete silt loam is very dark grayish brown or almost black and is from 14 to 20 inches thick. It is well supplied with decayed plant remains and does not differ noticeably from the surface soil of Marshall silt loam and Hastings silt loam. The upper part of the subsoil is decidedly compact, is 12 to 19 inches thick, and is composed of brown or dark grayish-brown dense clay which almost attains a clay-pan consistence. This material is not quite so dense as the corresponding layer in the true clay-pan soils so well developed in Saline, Clay, and Fillmore Counties. Crete silt loam, as mapped in Butler County, is not representative of the soil as mapped in other counties of the State. The lower part of the subsoil is light-brown, in many places yellowish-brown, loose friable silt. It begins about 3 feet beneath the surface and continues to an average depth of 50 inches. The upper part is very limy, the lime existing chiefly as small irregular nodules from one-eighth to one-half inch in diameter. The quantity of lime decreases with depth but the lime does not disappear, and the underlying loessial formation con-

tains sufficient of this material to produce a strong effervescence with dilute hydrochloric acid. The loess is extremely loose and floury and is composed largely of grayish-yellow silt, though locally it may contain a small percentage of very fine sand.

Crete silt loam presents no marked variations throughout the area of its occurrence in Butler County. It occurs almost exclusively in one area, about 9 square miles in extent, in the extreme southwestern part of the county. A few areas, 100 acres or less in extent, are near David City.

Areas of this soil are smooth and have very little slope. The almost total absence of surface irregularities is a characteristic feature. None of the soil is depressed and surface run-off, although very slow, is sufficient for good drainage. Underdrainage is somewhat restricted by the dense upper subsoil layer, but no part of the soil is affected by excess moisture in sufficient quantities to reduce crop yields, except in unusually rainy seasons.

Practically all of the Crete silt loam is cultivated. It is well adapted to all crops common to the region. Corn, wheat, oats, and alfalfa, ranking in acreage in the order named, are grown most extensively. In addition, some rye, vegetables, and forage crops are grown on most farms for home consumption. The acreage devoted to corn and wheat exceeds that of all other crops combined. Cattle feeding is practiced by many farmers. The cattle are purchased either from ranchers in the more hilly parts of the county or from the Omaha markets, are fattened on corn and alfalfa, and are shipped to Omaha or Chicago.

Crop yields depend largely on the quantity of rainfall and on the care used in crop and soil management. The ordinary yield of corn is about 35 bushels to the acre. Wheat, over a period of years, yielded about 25 bushels to the acre, oats about the same as corn, and alfalfa 2½ tons to the acre. Alfalfa is cut three times. Both wheat and oats mature before the dry weather of midsummer and, since the readily available moisture in the soil is mostly above the dense clay layer, the yields of these comparatively shallow-rooted and early-maturing crops are more uniform than those of corn and alfalfa.

This soil is easily managed. Clods are formed if it is cultivated when wet, but the lumps are easily reduced. The soil is very fertile and responds well to good farming methods. Its nearly level surface favors the use of tractors.

The current selling price of Crete silt loam is about the same as that of the Marshall and Hastings soils.

CASS FINE SANDY LOAM

Cass fine sandy loam has a dark-gray or dark grayish-brown friable surface soil composed largely of fine or medium sand, together with large quantities of organic matter. The latter constituent imparts the dark color to the soil. The subsoil consists of incoherent, gray fine sand which continues to a depth greater than 4 feet.

Although the profile described is typical of the greater part of the soil, as mapped in Butler County, a few variations are present. In places the surface soil contains an unusually large quantity of silt and very fine sand and approaches very fine sandy loam in texture. In such places the subsoil is also more silty than typical and is, there-

fore, more coherent. Another variation is caused by the presence of unusually large quantities of gravel below a depth of 24 inches. These variations are of local occurrence and are not sufficiently extensive to warrant locating on a map of the scale used in this survey.

Neither the typical soil nor the variations mentioned contain sufficient lime to react with dilute hydrochloric acid.

Cass fine sandy loam is the most extensive soil in the flood plains of Platte River. The largest development of the soil is north of Linwood. Areas are almost level, although locally they are modified by numerous elongated, meandering depressions and a few slight elevations.

Drainage is variable. Some of the soil occupies a position lower than that of Sarpy sand, although most of it lies slightly above the surrounding alluvial soils. The underlying water table is everywhere near the surface, and the subsoil, even in the elevated areas, remains very moist in places during much of the time.

This soil is used almost exclusively for hay and pasture land, largely on account of its uncertain drainage but also to some extent on account of the looseness and incoherence of the soil and the danger of blowing when the native sod is destroyed. Some corn is planted in the more protected situations, and yields are fairly good in average seasons. In wet years, however, the yields scarcely repay the expense involved in seeding and tilling the land.

The native vegetation in the more poorly drained areas consists largely of marsh grasses, sedges, and rushes. Needle grass and bluestem predominate in the better-drained areas and afford good pasturage and hay. Narrow strips of cottonwood and willow trees border most of the stream channels. None of the trees are of merchantable size.

Cass fine sandy loam has a current sale value varying from $40 to $75 an acre. The price depends largely on improvements and drainage.

CASS SILT LOAM

The surface soil of Cass silt loam is black or dark-gray friable silt loam, 12 inches thick. It is rich in organic matter. The upper part of the subsoil is grayish-brown, loose very fine sandy loam, and the lower part, below a depth of about 18 inches, is a mixture of gray, incoherent medium or coarse sand and gravel which continues to a depth greater than 4 feet. Neither the surface soil nor subsoil is calcareous, except locally where areas border areas of the Lamoure soils or where the soil has received limy sediments from higher-lying land.

This soil occurs only in a few small areas on the Platte River flood plains. It has weathered from recently deposited sandy sediments laid down by the stream during periods of high water. The silty texture of the surface soil results largely from the addition of fine-textured material from the near-by uplands.

Areas of this soil are prevailingly smooth. The soil lies only a few feet above the normal flow of the stream, and the water table is very near the surface. In seasons of heavy rainfall the surface soil often remains wet for long periods.

Cass silt loam is used almost exclusively for hay and pasture land. The native vegetation is chiefly slough grass and other wetland grasses. These produce from 1 to 2 tons of hay to the acre.

The hay is somewhat inferior to that cut from the better-drained soils of the county, but the high yield tends, in a measure, to offset the inferior quality.

CASS SANDY LOAM

The surface soil of Cass sandy loam is dark grayish-brown friable sandy loam, about 6 inches thick, underlain by gray sandy loam which continues to an average depth of 12 inches. The subsoil is gray or yellow incoherent sand which becomes coarser with depth. Locally gravel is present within 3 feet of the surface. The upper part of the surface soil contains a large percentage of organic matter.

Cass sandy loam occurs in the first bottoms of Platte River, chiefly in long, narrow strips along Clear Creek. Surface drainage is good, but the water table throughout the greater part of the soil lies near the surface. Owing to its small extent, none of the soil in the county is under cultivation but is used for pasture and wild-hay land. The hay yields from 1 to 2 tons to the acre.

SPARTA SAND

Sparta sand consists of light grayish-brown, incoherent sand to a depth of more than 3 feet. The surface 4 or 6 inch layer is commonly slightly darker than the remainder of the soil, owing to a small accumulation of organic matter. The entire soil is very poor in lime. Locally, it contains considerable fine gravel intermixed with the sand, especially near a depth of 3 feet.

The total area of this soil is about 4 square miles. The soil occupies sandy terraces or benches, chiefly in the Platte River Valley. The largest area is in the northwestern part of the county. Another is in Bone Creek Township, in the north-central part.

This soil has developed on sandy or gravelly alluvial sediments deposited by Platte River when it flowed at a higher level. Windblown sands from the surrounding sandy soils have also contributed to its formation. The soil is of such recent origin that sufficient time has not elapsed for the development of the dark-colored surface layer characteristic of the O'Neill soils. The O'Neill soils differ from Sparta sand only in their larger organic-matter content and the consequently darker color of their surface layers. Sparta sand is similar in physical characteristics to Valentine loamy sand, but it contains a little less organic matter in its surface soil and is more even in relief.

The surface of this soil is flat or very gently undulating, except locally where wind has heaped the incoherent sand into low, rounded ridges and knolls resembling those in the Valentine soils. The soil lies from 5 to 15 feet above the stream channel. Surface drainage is not established, but the surplus moisture is rapidly absorbed by the loose, porous sands, and the soil is very droughty.

Sparta sand is not adapted to farming, because of its low content of organic matter, excessive underdrainage, and the danger of soil drifting when the native sod is destroyed. Practically all of it is used for grazing land. Corn and potatoes are grown on a few of the more protected areas, but the yields are low, except during seasons of ample rainfall.

The native vegetation consists chiefly of little bluestem, stipa or needle grass, Muhlenbergia, and sand reed grass. Most of these

grasses grow either in bunches or patches separated by small areas supporting no vegetation. Only about one-half of the surface is sodded, and the land does not have a high value even for grazing.

SARPY SAND

Sarpy sand consists of very light brown or grayish-brown, loose, incoherent fine or medium sand which continues to a depth greater than 3 feet with little change, except that the lower part of the subsoil is in most places slightly coarser in texture. The surface 6 or 8 inch layer is somewhat darker than the remainder of the soil, owing to a slight accumulation of organic matter. The soil is rarely noticeably limy.

Sarpy sand occurs in only a few small areas and narrow strips, chiefly in the Platte River Valley. Some of the strips occupy natural levees along the river channel. The rest occur either within larger areas of Cass fine sandy loam or on long, narrow ridges between abandoned stream and overflow channels on the valley floor.

This soil is composed of recently deposited sandy alluvium laid down by the river during periods of high water. It has not weathered sufficiently to have developed the dark-colored surface layer characteristic of the Cass soils. In some places it resembles river wash, but it is a little more stable and is not so greatly influenced by each slight rise of the stream.

This soil is unsuited for farming purposes, on account of its looseness and instability. It is all used for pasture land. The covering of grasses is very sparse, and the land does not have a high value even for grazing. In a few places the grasses are not sufficiently thick to hold the soil, and the wind has whipped the sand into low, rounded knolls and ridges.

Narrow strips of willow and cottonwood occur along the stream channels.

VALENTINE LOAMY SAND

The surface soil of Valentine loamy sand is gray loamy sand from 15 to 24 inches thick. The subsoil is yellowish-gray, loose, incoherent sand which continues to a depth greater than 4 feet without change in color or texture. The soil is poor in lime. The surface soil contains a little organic matter but not enough to greatly darken the sandy material or to prevent it blowing when it is not protected by vegetation.

Areas of this soil are strongly undulating or rolling. Many are hummocky and characterized by low, rounded ridges and knolls separated by shallow depressions. Surface drainage is not established, as the porous soil readily absorbs the rainfall.

Most of the Valentine loamy sand probably came originally from the sand sheet underlying the loess, but the sand has been so shifted by wind and water and subsequently weathered that its origin can not be definitely determined.

This soil occurs largely in irregular areas, varying in size from 320 to 640 acres, in the Platte River Valley. Most of the soil is adjacent to areas of Knox silt loam. Two of the largest areas are southeast of Octavia and southwest of Linwood.

This soil is of very little agricultural importance in Butler County, on account of its small extent and instability. Only a very small part of it is devoted to the growing of crops, chiefly corn. The yields

are low, except in the most favorable seasons, owing to the low water-retaining power of the sand. Nearly all of the soil is devoted to grazing. The native vegetation consists of sand reed, stipa, grama, buffalo, and little bluestem grasses. These grasses support a cow or horse on each 6 or 8 acres during the summer grazing season.

BUTLER SILT LOAM

The surface soil of Butler silt loam is friable or only slightly compact silt loam containing considerable clay. It is extremely variable in thickness, ranging from 4 to about 14 inches. The color also varies considerably. The material is very dark, in many places being almost black. In many of the soil areas, however, the intensity of the color is more or less reduced by the presence of white, floury silt. The silt may occur as a thin sprinkling, scarcely noticeable, in the soil mass or it may be sufficiently abundant to greatly lighten the naturally dark color, especially in the lower part of the surface soil. In some places the white material becomes so concentrated that it forms a light-gray or almost white floury silt layer between the surface soil and the subsoil. The subsoil consists of two layers which differ widely in character. The upper layer is very dark grayish-brown or almost black clay. It is a true clay pan, being extremely compact and comparatively impervious. It is from 12 to 24 inches thick. The lower subsoil layer is grayish-brown or almost white friable silt. It is rich in lime, which occurs chiefly as concretions, spots, splotches, and other visible forms. The layer continues to an average depth of about 4 feet and is underlain by grayish-yellow, loose, silty, moderately limy loess.

Except for the variations in the surface soil, Butler silt loam is uniform throughout the area of its occurrence in Butler County. It occurs in numerous small areas throughout the more nearly level uplands. Most of the patches are within areas of Hastings silt loam. The two largest ones, each including about 1,200 acres, are near David City, in the central part of the county. Few of the remaining areas exceed 160 acres in extent.

This soil is poorly drained. The basins have no surface outlet, and all surplus moisture is removed either by seepage or evaporation. The soils are not excessively moist, however, except for short periods after heavy rains.

Butler silt loam is of little agricultural importance in Butler County on account of its small extent and poor drainage. A few of the areas in which the surface soil is unusually thick are used for corn and wheat, but the yields are low except in the most favorable seasons.

Most of this soil is included in pasture and hay land. It supports a rank growth of water-loving and prairie grasses which, although somewhat inferior in quality to the grasses on better-drained soils, give high yields and afford fair pasturage and hay.

Current sale values for this soil are not available, as it occupies only a small part of the farms on which it occurs and is sold in connection with better farming land.

SCOTT SILT LOAM

The surface soil of Scott silt loam is variable but commonly consists of very dark grayish-brown friable or slightly compact silt loam from

3 to 6 inches thick, underlain by ash-gray, floury material of similar texture, from 2 to 5 inches thick. Beneath the surface soil is a heavy clay pan which continues to a depth of 4 or 5 feet and consists of stiff, almost impervious, structureless clay. The material is commonly bluish gray or dark gray. It is in no place so dark as is the corresponding layer in the Butler soils. It everywhere contains numerous rust-brown streaks, stains, and splotches and scattered black concretions which seldom occur in Butler silt loam as mapped in Butler County. Below a depth of 4 or 5 feet the clay pan gradually gives way to looser, more friable, and lighter-colored material, and yellowish-gray or almost white floury silt occurs about 6 feet beneath the surface. The light-colored silt, known by Nebraska geologists as loess, is the material from which the soil has weathered. The loess under Scott silt loam is not limy to a depth of more than 7 feet, and the entire soil gives a more or less acid reaction.

Scott silt loam is fairly uniform throughout the area of its occurrence in Butler County, except in the color of the surface soil. In some areas the upper part of the surface soil seems to be well supplied with thoroughly decomposed organic matter and is black, locally resembling muck in appearance. The lower part, however, is in most places lighter in color. In other areas there is apparently a deficiency of organic matter, even near the top of the ground, and the entire surface soil is very light in color, the lower part being almost white. These characteristics are largely the result of extremely poor drainage. The soil occupies basinlike depressions similar to those in which the Butler soils occur, but the basins are commonly a little deeper and the soil is covered with water for longer periods each year than is Butler silt loam. The basins are scattered throughout the more nearly level uplands in all parts of the county. Although numerous they are not large, few exceeding 25 acres and most of them ranging from a few square rods to about 5 acres in extent. One of the largest and most typical areas is 4 miles southwest of Millerton, in the southwestern part of the county.

Scott silt loam is of little agricultural value in Butler County, on account of its small extent and poor drainage. Practically all of the soil is included in pasture or hay land. Several of the smaller areas within cultivated fields are tilled for economic reasons, but crop yields on them are usually low and seldom repay the expense involved in labor and seed.

Most of this soil is covered with a luxuriant growth of water-loving grasses which, when cut for hay, yield from three-fourths to 1¼ tons to the acre. The hay, however, is of poorer quality than that obtained from better-drained lands. In the more poorly drained situations the vegetation consists almost entirely of rushes and sedges and the land has no value even for hay production.

Sale values are not available for this soil. It commonly occupies only a small part of the farms on which it occurs and is sold in connection with better farming land.

RIVER WASH

The miscellaneous material classed as river wash occupies sand bars and sand flats along Platte River. It consists of a mixture of light-yellow, fine, medium, and coarse sand, together with very coarse sand and gravel. The material lies only a few feet above the normal flow

of the river and is subject to inundation with each slight rise of the stream.

River wash is not permanent. It undergoes change with every overflow. Even when the river is at normal level the material is more or less continually shifted about by the varying currents. It is also modified to a considerable extent by the wind.

Only 256 acres of river wash occur in Butler County. The material supports a scant grassy vegetation and has no agricultural value. Some of it is covered with a rather dense growth of willow and cottonwood trees, which afford fuel and posts.

SUMMARY

Butler County is in east-central Nebraska, in the fourth tier of counties from the south boundary and in the third from the east. It comprises 588 square miles.

The physiographic division known as the Nebraska plain occupies about 65 per cent of the uplands of the county and occurs in the southwestern part. It is a smooth or gently undulating upland plain little modified by erosion.

The drift-hill area is in the southeastern part of the county and includes about 10 per cent of the uplands. The surface features in this area are the result of severe erosion, and the land is extremely rough and hilly.

The loess hills are north of the drift hills and east of the Nebraska plain. They are the result of erosion, but the surface has not been so reduced and roughened as in the drift-hill area, and the relief is strongly rolling or hilly.

The Platte plain is a broad lowland belt extending in an east-west direction across the northern edge of the county. It includes the flat or gently undulating alluvial lands along Platte River and lies from 100 to 150 feet below the general level of the uplands.

The county has an average elevation of about 1,450 feet above sea level. The general slope is to the east. Drainage is effected by Platte and Big Blue Rivers, together with their tributaries. With the exception of the flatter upland areas, and locally the bottom lands, the county is well drained.

Settlement in Butler County began in 1857, and the county was organized in 1868. The population was 14,606 in 1920, according to the last Federal census report. David City is the county seat and largest town. It has a population of about 2,400.

The transportation facilities of Butler County are good. Railroads cross the county in several directions and furnish good connections with Lincoln and Omaha. Public roads follow most section lines.

The climate is favorable for the growing of hay crops, vegetables, and grains, and for the raising of livestock.

The agriculture of the county consists of diversified farming, including the growing of grain and hay and the raising of livestock. The principal crops, in the order of their acreage, are corn, wheat, oats, alfalfa, rye, and potatoes. The livestock industry consists chiefly of cattle grazing and the feeding and raising of hogs.

There are in Butler County two broad groups of soils, namely, those in which the soil-forming processes control the character of the soils and those in which the parent geologic formations exert the con-

trolling influence in determining the soil characteristics. The soils in the former group are well developed and those of the latter group are imperfectly developed.

Twenty-three different types of soils were recognized. Those which belong to the well-developed group include the soils of the Marshall, Hastings, Crete, Butler, Carrington, Scott, Waukesha, and Hall series, and those of the imperfectly developed group comprise the soils of the Knox, Valentine, Judson, O'Neill, Bremer, Sparta, Lamoure, Wabash, Cass, and Sarpy series.

Marshall silt loam is the most extensive and important soil of the uplands. It is highly productive, is friable throughout, and is well adapted to all crops common to the region.

Hastings silt loam ranks second in acreage among the upland soils. It is similar to Marshall silt loam in most respects but has developed a slightly more compact upper subsoil layer.

Crete silt loam occurs chiefly in the extreme southwestern part of the county. It differs from the Marshall and Hastings soils chiefly in having an extremely dense upper subsoil layer. It is fairly well drained.

Butler silt loam and Scott silt loam occupy basinlike areas scattered throughout the Marshall, Hastings, and Crete soils. They are the most poorly drained of the upland soils and have developed extremely compact claypanlike layers in their subsoils.

The Carrington soils are somewhat similar to the Hastings but commonly occupy more uneven areas.

The Waukesha and Hall soils occupy terrace or bench positions in stream valleys. They are very strong and fertile and retain moisture well.

Knox silt loam occupies upland positions in close association with Marshall silt loam.

The Valentine soils have weathered from wind-blown sands. They are very poor in organic matter and are best adapted to grazing.

Judson silt loam has not weathered sufficiently to have formed definite layers and is uniform in color and texture to a depth of 3 or 4 feet.

The O'Neill and Sparta soils occupy sandy terraces. The surface soils of the O'Neill soils have accumulated considerable organic matter and are very dark. The Sparta soils are very poor in organic material and are light in color.

Bremer silt loam and Wabash silt loam are rather poorly drained and poor in lime. Bremer silt loam occupies low terraces slightly above stream overflow and Wabash silt loam occurs on the flood plains of streams.

Lamoure silt loam differs from the Wabash soils only in the higher lime content of its subsoil. It occupies flood-plain positions and is subject to overflow.

The Cass soils have accumulated considerable organic matter and have dark-colored surface soils. The Sarpy soils are of more recent origin, are poorer in organic matter, and are consequently lighter in color than the members of the Cass series.

River wash is a miscellaneous material occupying sand bars and sand flats along Platte River.

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[PUBLIC RESOLUTION—No. 9]

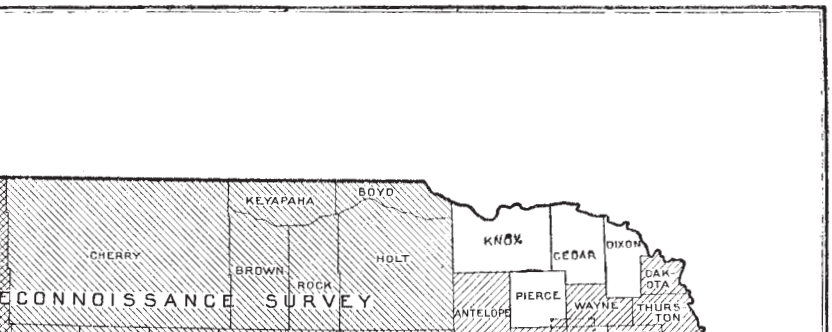
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture"

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided,* That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils and on July 1, 1927, the Bureau of Soils became a unit of the Bureau of Chemistry and Soils.]



Areas surveyed in Nebraska, shown by shading

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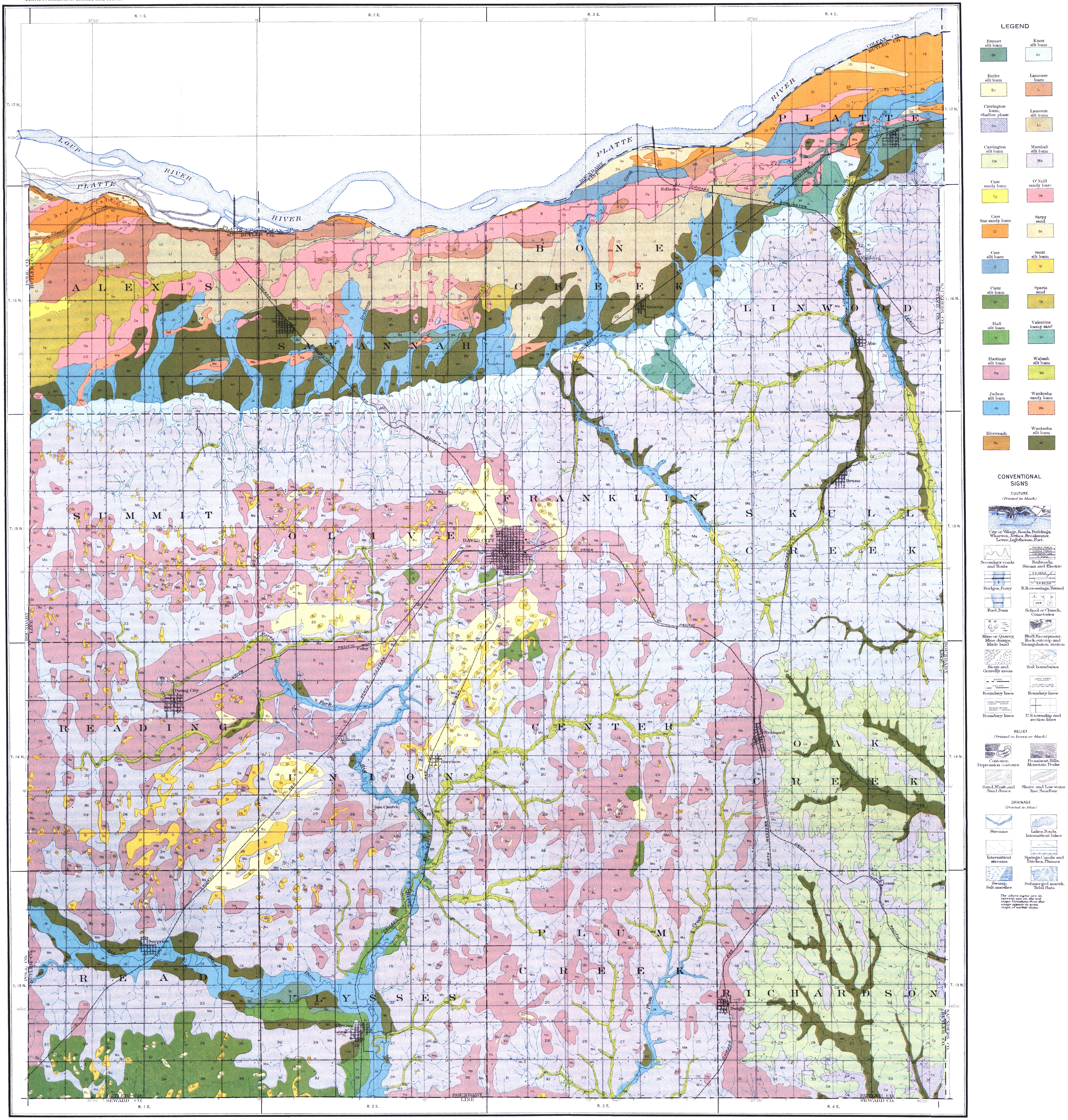
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
BUTLER COUNTY
NEBRASKA

UNIVERSITY OF NEBRASKA
STATE SOIL SURVEY DEPARTMENT OF THE
CONSERVATION AND SURVEY DIVISION
G. E. CONDRA, DIRECTOR



Thomas D. Rice, Inspector, District 3.
Soils surveyed by A. W. Goke, U. S. Department of Agriculture, in charge, and G. E. Bates, Nebraska Soil Survey.

Scale 1 inch 1 mile

Field Operations
Bureau of Soils
1924